SCIENTIFIC AMERICAN

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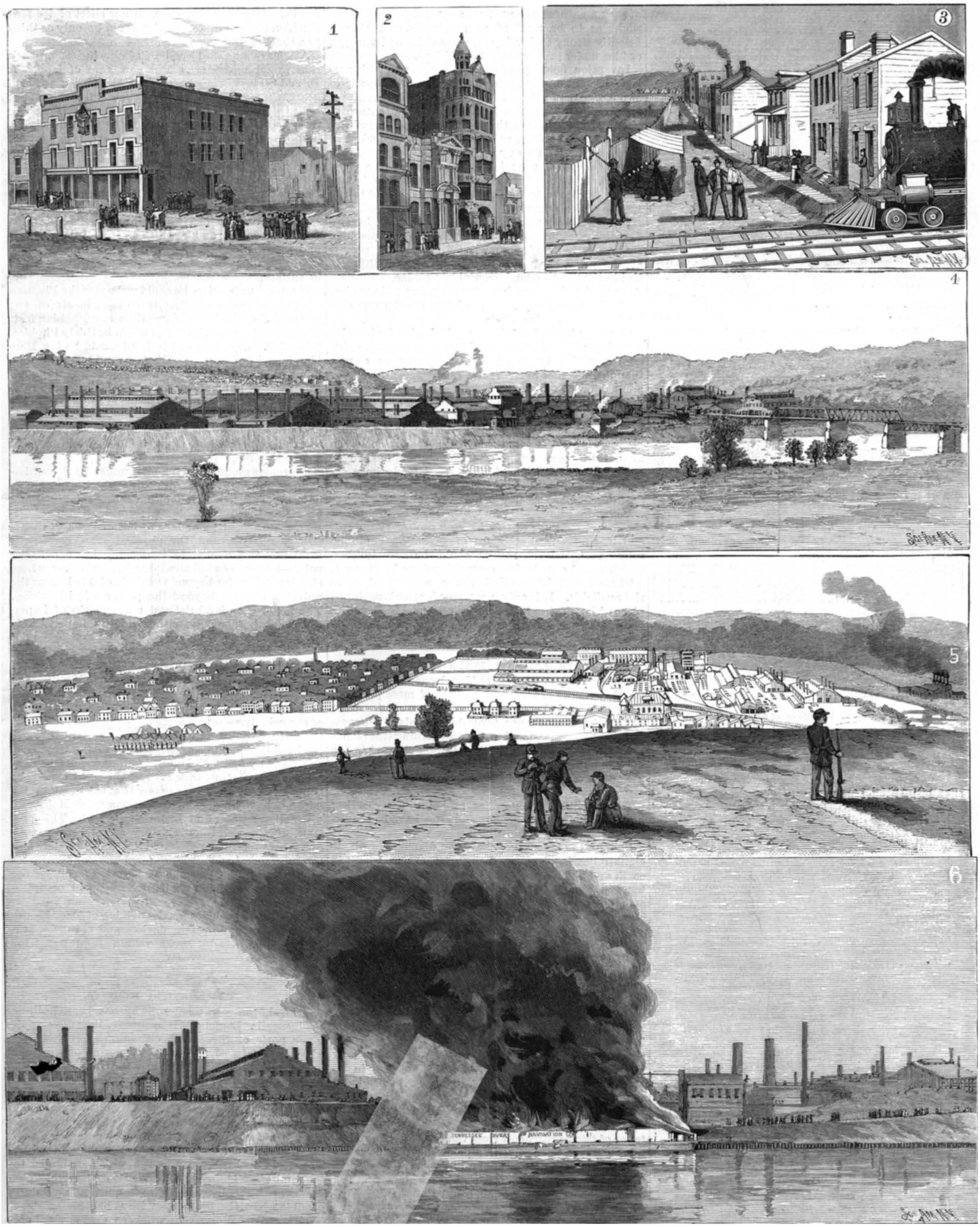

1. Amalgamated Association headquarters, Homestead. 2. Carnegie office, Pittsburg. 3. Street separating workmen's homes from the mills. 4. River front view of Carnegie mills. 5. Carnegie mills and part of Homestead. 6. Attempt to burn barge with Pinkerton men.

THE CARNEGIE STEEL WORKS, HOMESTEAD, PA.—[See page 116.]

Scientific American.

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No. 868.

For the Week Ending August 20, 1892.

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PSYCHOLOGY OF INVENTION.

In all that has been written on how to invent, methods of invention, suggestions to inventors, etc., the advice usually given when condensed to the fewest words has been, "Keep on thinking." This is good as far as it goes, but thinking, unless it has a basis of knowledge, is valueless. The inventor must deal with existing materials, whether they be thoughts or matter, in various forms. He is no more able to create thoughts than matter. The mind cannot be coerced, new thoughts will not come at command.

If a conception of any subject be carefully investigated, it will be found to have some relation to a former experience. Possibly such experience may have been of such a nature as to produce a mental impression so slight as to be received unconsciously, and still sufficiently strong to develop into a well-defined thought or idea under proper mental conditions.

Invention being practically synonymous with new thoughts, and thoughts being the outgrowth of knowledge, the value of knowledge to the inventor is apparent, even though it may be in the nature of obscure impressions of the memory, vague suggestions from men and things, or broad yet accurate and practical information on any subject.

It is a fact that the mind, when occupied on a given subject, and forced to consider correlated subjects, acquires the penetrating quality which is vital to the success of the inventor.

It is while knowledge is being acquired in any direction that inventions in that line become possible, and conceived under such conditions they possess greater value, because the work is done intelligently and in the light of fundamental knowledge.

The works of such an inventor are ascribed to genius, while they really represent persistent effort supported by knowledge.

The term invention is here applied with its broader meaning, which includes the idea of calling into existence anything based on or originating in a new thought, whether in the realm of science, abstract or applied, or art or letters.

After all, invention is little more than an excursion beyond the boundaries of present knowledge, rendered possible by the accumulated experience of ages past. Progress is hindered by the fact that men re-enact the same things generation after generation, instead of acquiring a knowledge of what has already been accomplished, and, with such knowledge as a basis, pushing forward to new fields.

Inventors who have followed the plan here outlined have achieved both distinction and pecuniary reward, and if the general standard of invention could be raised to this level, results could be accomplished which would overshadow everything done in the past.

There is certainly no limit to the amount of material available. It is only necessary for the inventor to place himself in the proper relation to existing materials to enable him to reach out and take the reward.

THE EARTH AND THE INNER MOON OF MARS.

The scrutiny of the planet Mars by astronomers during the summer of 1892, with the aid of more powerful telescopes and better equipped observatories than have existed at former favorable periods of observation, and the sensational articles concerning this planet and its two little moons that have appeared in the daily papers, have aroused great popular interest in the affairs of the earth's next door neighbor of the solar system.

The satellites are peculiar as being the smallest heavenly bodies whose orbits and sizes have been even approximately determined.

Phobos, the inner moon, having a diameter of about eight miles, is of a size easily comparable with the earth and objects upon the earth's surface, its diameter and circumference being respectively almost exactly one one-thousandth of the earth's diameter and circumference.

Let us suppose everything on the surface of the earth to be reproduced on the surface of Phobos, as men, trees, ships, mountains, rivers, etc., all reduced in size proportionally. It would be only necessary to divide by one thousand the dimensions of any earthly object to ascertain its dimensions as modeled on a Phobian scale.

A man six feet high would, on this scale, stand 0·072 inch of our measure on Phobos, and looking down with our human eyes to find him, we should have to look for an oval object about 0·022 inch diameter in its longest dimension, as we should see only the head and shoulders. A good magnifying glass would be needed to determine the real character of the mere speck that would be visible to an unaided human eye at a distance of two or three feet from the surface, on which it would be seen to crawl with a painfully slow motion.

A few species of our larger birds could be seen in flight without a magnifying glass; only a few, the ostrich, the condor, the swan, could thus be discerned when their wings were not extended.

The altitude of the highest mountains would not exceed thirty, and the profoundest depths of earthly seas yet sounded would be represented by twenty-six of our feet.

A ship of the size of the Great Eastern sailing on a Phobian ocean would be less than 7½ inches long. A right whale of average size reduced to our Phobian scale would be less than five-eighths of an inch long.

A railway train of ten vestibule cars with locomotive and tender would have a length of less than six of our inches and its breadth would be represented by a line less than 0·02 of an inch in thickness.

An earthly river, two miles in breadth and one hundred feet deep, would be represented on Phobos by a stream a little more than ten and one-half of our feet in breadth, and one and one-fifth inches in depth. Let this river be frozen over with a sheet of ice four Phobian feet thick, and the ice would be only as thick as a sheet of drawing paper.

A square two and one-half of our inches on each side would represent a Phobian acre of land. A United States postage stamp would cover a space of nearly three Phobian city lots. A city like New York built to the Phobian scale would have streets ranging from four-tenths to one and two-tenths inches wide, and these would pass between buildings ranging from six-tenths of an inch to two and four-tenths inches in height.

Having thus constructed an earth to the scale of Phobos, in which, to unaided human eyes, only the largest quadrupeds and fishes would be visible, wherein we should have to look for all but the largest birds with microscopes, and in which all insect life would be undiscernible by any means at present known to us, Let us suppose an ordinary sized man transferred to its surface.

If a good pedestrian, he could walk over the Phobian equator, circumnavigating the globe, in six of our hours, making strides of three thousand Phobian feet. The soles of his walking boots would be thirty Phobian feet thick. Each hair of his head would be ten Phobian inches in diameter. His feet would be over nine hundred Phobian feet long and about three hundred Phobian feet in breadth. In walking he would raise the toes of his feet above the heads of the Phobians to a height of five hundred feet. If his stature in earthly measurement be taken as five feet ten inches, he would tower into the Phobian sky to a height over one and one-tenth miles.

Enormous giant as such a man would be to our imaginary Phobian, he is, as compared with our globe, no larger than such an inhabitant of that satellite would be as compared with his little world. The truth is, there is no absolute standard of large or small. Size is strictly relative, and the physical man, considered in relation to the universe, is nothing but a material point—a center of vital mental and moral forces, whose effects reach as far beyond the limit of his ken as the universe extends beyond the power of his vision. The life of man is a brief and narrow strip of imperfect light, bordered on either side by impenetrable mystery.

Memorial Fair Coins.

Congress has appropriated two and a half millions of dollars to help the World's Fair, to consist of memorial half dollars, or "Columbian half dollars." The designs of the coin have been selected. The reverse will show the main building of the exposition, and the obverse the head of Columbus. The plaster cast of Columbus was made by A. S. J. Dunbar, sculptor, of Washington, from a portrait which is recognized by experts as being as nearly authentic as any that exists, and is believed to have been painted for Domenico Malipiero, a Venetian senator and historian, in 1501. This portrait, with a well-traced history approving its antiquity, was recently purchased by the United States Consul-General at Frankfort, Germany, for Mr. James V. Ellsworth, of Chicago. The work of coining the souvenir "Columbian half dollars" will occupy a month or six weeks.

The bill also provides for the striking of 50,000 bronze medals, with appropriate devices and emblems, at a cost of $60,000, and 50,000 vellum impressions for diplomas at a cost of $43,000.

A Water Weight Railroad.

A novel form of inclined railway has been built at Bridgenorth, England. It connects the upper and lower parts of the town, communication between which was formerly provided by means of steps cut in the solid rock. The length of the track is rock 201 feet, but its vertical rise is 111 feet. There are two cars, on separate lines of rail, and they are connected by a steel cable passing round a wheel at the top. They are thus balanced, and a preponderating weight is given, whichever one is at the top, by pumping a supply of water into a tank placed in the frame of the car. The steel rails are secured to ties which are bolted to the solid rock and also embedded in concrete. The brakes are normally on the wheels, and motion is only possible while the brakesman turns his handle. The track is cut out of the solid rock, so that it shall not spoil the beauties of the landscape.

Four Hundred Years.

The approaching celebration of Columbus Day is in honor of a historical event which, among the events whose centennials the world has arranged to celebrate, is without a parallel in world-wide importance, exact dating, and remoteness in time.

With the exception of a few battles, whose dates are fixed by their historical connections with ancient eclipses, there are no events of great importance, earlier than the destruction of Jerusalem, whose dates are not in dispute. The time of Christ's birth is in almost hopeless obscurity, and the date of the crucifixion is variously assigned. From the rapidly accumulating evidence for this latter date, the writer is confident, however, that the twentieth century will witness, after nineteen centuries through which the true date has remained unknown, the grand celebration of a centennial Easter day by the whole Christian world.

The days that have passed since the discovery of America by Columbus have been counted with undoubted accuracy, but the number that are needed to make four hundred years is a question that admits of debate and that has divided opinion concerning the true date for Columbus Day. It is not a question that is simply solved by adding 400 to the year of the discovery and assuming that four centuries are comprised between October 12, 1492, and October 12, 1892. The first ninety years in this interval was measured by a calendar in which the average length of the year was exactly 365¼ days, and the remainder is being measured in a calendar that omits three continual leap years in four centuries, and thus makes the average length of the year 10 minutes 48 seconds shorter. When the change was made from the old to the present calendar ten days were omitted, so that the year 1582 contained but 355 days.

Because of this irregular keeping of the calendar, October 12, in the year as it is now observed, marks a point nine days earlier in the autumn season than it did in the century when Columbus made his discovery. This error has been recognized by resolutions in Congress, and President Harrison, in conformity therewith, has proclaimed October 21, instead of October 12, as the day on which to "express honor to the discoverer and appreciation of the great achievements of the four completed centuries of American life."

The impression is current in many minds that a year is the period of time that the earth requires to make the circuit of the sun. This period is known as the sidereal year, but it is not the year to which the calendar that we now use is adjusted, and which has the length that is best adapted to human affairs. For this purpose a period of time known as the tropical year, which is 20 minutes 24 seconds shorter than the sidereal year, is employed. This is the period to which the alternations of summer and winter, of long days and long nights, most nearly conform. Exactly stated, it is 365 days 5 hours 48 minutes 45½ seconds in length. Our present calendar is adjusted to this year with great precision, and by it the anniversary dates for all modern historical celebrations are determined.

This period will, therefore, probably be regarded for all time to come as *the* year. From the standpoint of astronomy it may be most concisely defined as the period in which the earth nods to and from the sun. This nodding movement is the resultant of two motions which the earth has with reference to fixed space.

In an article published in the SCIENTIFIC AMERICAN SUPPLEMENT, No. 778, two years ago, the writer first pointed out the mistake that had been made in selecting October 12 for the Columbian celebration. In that article it was shown that 146,097 days intervened between October 12, 1492, and October 21, 1892. Four hundred of our modern calendar years contain this number of days, as was there calculated, and four hundred tropical years are but three hours short of the same interval. For these reasons the 21st of next October will be the appropriate quadri-centennial day. Then the sun will return again for the four hundredth time to the same position in the heavens, and pursue nearly the same course that it did on the New World's natal day.

As the period between successive nods of the earth to the sun has come to be recognized as the year to which human affairs are adjusted, it is well that October 21 has been finally selected, since it points off four hundred of these periods as the span of four hundred years.

The four hundredth sidereal year, or true revolution of the earth around the sun, also has a certain claim to consideration as an appropriate anniversary date. This point of time will be reached on the evening of October 26 in this country and on the morning of October 27 in Europe. Then for the four hundredth time since the sighting at daybreak of Watling's Island the relation between earth, sun, and stars will be such that there will again be on watch the constellations that looked down upon that auspicious occasion.

The anomalistic year is yet another cycle of a still different length that is made by the earth in its course about the sun. The earth travels in an elliptical orbit with the sun at one of the foci of the ellipse. This ellipse, or track of the earth, does not remain in a fixed position, but shifts slowly around in the same direction that the earth is traveling, as though it were laid out on a gigantic turntable.

The real shape of the earth's orbit cannot be well illustrated, in perspective, and if pictured in plain view its appearance would be so like a circle that the fact that it was not would hardly be revealed except by measurement. On the second of January the earth passes the part of the orbit which is nearest the sun, and in July it passes the point that is farthest away. The time between two passages of either of these points is 4 minutes 39 seconds longer than the sidereal year. After the earth has completed its circuit about the sun, it must therefore continue on for this length of time before it will be again at the same part of the elliptical orbit. Four hundred anomalistic years, or the four hundredth return to the same point on its orbit that it occupied at the time Columbus landed, will be completed on the 28th of next October.

In the time of Columbus, the calendar instituted by Julius Cæsar, as revised by Augustus, was generally followed, and that calendar, which is still used by Russia and Greece, differs from the one which we now use by twelve days. It will therefore be October 12 with them, and four hundred Augustan years will have elapsed when it is October 24 here.

S. W. BALCH.

The Acids of Fruits.

We know that many vegetable and fruit products are esteemed rather for their pleasant or refreshing taste, and for their anti-scorbutic properties, than for any nutritive value which they may be assumed to possess. Yet even fruits of that character are especially valuable as additions to our daily diet, on account of the potash salts and mild vegetable acids they contribute to the blood. We learn from Johnson's *Vegetable Food of the World* that the grateful acid of the rhubarb stalk arises from the malic acid and binoxalate of potash which it contains. The acidity of the lemon, orange, and other species of the genus Citrus is caused by the abundance of citric acid which their juices contain; that of the cherry, plum, peach, apple, and pear from the malic acid in their pulp; that of gooseberries and currants, black, white, and red, from a mixture of malic and citric acids; that of grapes from a mixture of malic and tartaric acids; that of the mango from citric acid and a very fugitive essential oil; that of the tamarind from a mixture of citric, malic, and tartaric acids; the flavor of asparagus from aspartic acid, found also in the root of the marshmallow; and that of the cucumber from a peculiar poisonous ingredient, called fungin, which is found in many species of fungi, and is the cause of the cucumber being objectionable to some persons.

It will be observed that rhubarb is the only product which contains binoxalate of potash in conjunction with an acid. It is this ingredient which renders rhubarb so wholesome at the early commencement of the summer, though in certain cases, known to medical men, its use may be injurious.

The following table, compiled from some analyses by Prof. Berard, shows the percentage average chemical composition of five unripe fruits and of eight ripe fruits, comprising apples, pears, gooseberries, grapes, plums, cherries, apricots, and peaches:

PERCENTAGE AVERAGE COMPOSITION OF FRUITS.

	Unripe.	Ripe.
Water	85·7	78 7
Albuminoids	0·7	0 6
Sugar	4·0	12·9
Vegetable acids	1·5	1·3
Pectose and gum	4·3	3·7
Cellulose, etc.	3·8	2·8

The data thus given show that there is a considerable decrease in the watery particles of fruit as it approaches its full ripe character, resulting in a difference of 7 per cent, while the sugary constituents increase during maturation in a corresponding degree, rising from an average of 4 to nearly 13 per cent.

There is very little actual decrease in the percentage of acids from the green to the ripe stage of fruits, but the acidity becomes neutralized by the increase of sugar as the fruit approaches maturation.

Many persons know from experience how much more pleasant and agreeable fruit is when gathered and eaten direct from the tree. This is undoubtedly in part due to the freshness and briskness of the vegetable acids contained in the fruit, which, when so gathered and eaten, have not time to change into any other substance. Stale fruit, on the other hand, is unpalatable from the very fact that it has lost this pungent and brisk taste.

Pectose forms the substance known as vegetable jelly, and it is to this constituent of fruits that jams owe their firmness. Cellulose is the fibrous part of fruits, and it is in this portion that we should find the largest proportion of mineral salts, potash, etc.—*The Gardeners' Chronicle.*

Smokeless Powder.

On July 2, on the invitation of the directors of the Smokeless Powder Company, a number of gentlemen interested in military matters inspected the new works of the Smokeless Powder Company at Barwick, near Ware, England, and witnessed an exhaustive trial of the qualities of the explosives manufactured by the company. About a hundred gentlemen were present, among them being Colonel Mackinnon, secretary of the National Rifle Association; Major De Hoghton, from the School of Musketry at Hythe; Colonel Henry Platt, of the Carnarvonshire Militia; Mr. Dougall, the managing director of the company; Mr. Rigby, well known both as a rifleman and as an expert in the making of rifles; and representative members of the leading firms of gunmakers.

The morning was spent in inspecting the various buildings, spread over a space of 126 acres inclosed in a ring fence, and in watching, without understanding, the process of manufacture, for, as may readily be conceived, the delicacies of the process are kept absolutely secret at this establishment, which claims to be the only one in the kingdom in which smokeless powder is produced. The visitors saw rolls of coarse paper churned into fluff as fine as cotton wool and washed in a mash tub. They saw, also, men engaged in mixing malodorous acids. They saw great grindstones crushing some yellow substance, understood to be a combination of the acids and the paper in some unknown proportions; they saw the yellow powder treated by the granulating sieves, dried, sifted, packed, and stored; and at the end they were no wiser than they had been in the beginning. After luncheon, however, came proof positive that the various grades of nitro-compound produced by the company, a compound said not to be affected by damp or heat, had several definite virtues. First came a trial with a revolver, then trials with rook rifles, cadet rifles, and like weapons, at short ranges. Neither with them nor a sporting rifle nor with a fowling piece was there any substantial smoke. A slight blue and evanescent wreath of vapor rather than smoke followed each discharge, and the smoke following the discharge of a cartridge or two loaded with black powder was in marked contrast.

The more effective trials, however, were at a longer range. First the powder was tried in the Mauser, Beaumont, Mannlicher, and various other foreign rifles, as well as in the 0·303 and the Martini. Not only was there no smoke, but excellent practice was made, particularly by Mr. Luff, of the North London Rifle Club. Then five men, having the spectators at the 400 yards firing point, fired volleys at 300 yards and at 200 yards, the result being that no substantial wreaths of smoke were visible. Finally, 500 shots were fired with the powder from the Maxim gun, with the result that there was very little smoke to be seen, although ten shots with black powder made an opaque cloud. Altogether the trial was of high interest and importance.—*London Times.*

The Bacillus of Measles.

Germs have been found by various investigators in the blood and secretions of patients suffering from measles. None, however, have been certainly proved to be active agents in the production of the disease. Very recent investigations are those of Canon and Pielicke, of Berlin, and they are reported in the *Berliner Klinische Wochenschrift* for April 18. There seems ground for the belief that the germ they have discovered is the active cause of the disease. It is a bacillus varying considerably in length and appearance under different conditions. It was found in the blood of fourteen patients sick with measles. A similar germ was also found in the sputa and the nasal secretions. It was present during the whole course of the disease, and occasionally for two or three days after active symptoms had disappeared. It was most abundant at the time of defervescence. In seven cases in which active symptoms had disappeared, but in which the rash had not wholly faded, the bacillus could not be discovered. This bacillus is undoubtedly different from any germ yet described in connection with measles. It is to be hoped that the belief of the discoverers will soon be confirmed by the investigations of others.—*N. Y. Med. Jour.*

George Sydney Percival.

The death of George Sydney Percival on the 1st inst. cut short a career of unusual promise. With what seemed at times almost a genius for mechanics, a love of study, and a conscientious devotion to his work, regardless of time or personal comfort, Percival at the age of 25, and with only two years' practical experience, had won the confidence of one of the principal engineering firms in the country, being intrusted by it with novel designing as well as the erection of costly steam plants. He was a member of the American Society of Mechanical Engineers, also of the First Battalion Naval Reserve, and a graduate of the Columbia College School of Mines.

UNSCIENTIFIC AND SCIENTIFIC DIVINING RODS.

BY GEO. M. HOPKINS.

Notwithstanding the tendency of scientific knowledge and general enlightenment to dissipate superstition, the proportion of believers in certain kinds of demonstrations attributed to the supernatural is beyond belief; yet when we find, on investigating the subject, that many coincidences have occurred which seem to establish the claims of the advocates of such

Fig. 1.—FORKED TWIG DIVINING ROD.

beliefs, it is no wonder that some of these notions gain credence, especially in view of the fact that the majority of unsuccessful experiments are never made known.

The divining rod—so called—is a very ancient device, but the belief in its efficiency is as strong to-day as it ever was, yet there is no scientific reason why it should be of any use whatever for any of the purposes to which it is applied. The ancient divining rod (Fig. 1) consisted of a forked twig of hazel, apple, or any fruit-bearing tree. It was held in the hands with the branches both lying normally in the same horizontal plane, with the crotch pointed either toward or away from the body of the operator. It was carried in this position over the ground, and whenever the forked twig bent downwardly it indicated proximity to water, minerals, or metals. The same performance is gone through with in these times, and we often hear of remarkable successes attained by modern operators. These successes are due partly to the good judgment of the operator, but mostly to sheer luck or chance. The dipping of the rod is not due to the action of the water or minerals, but to the voluntary or involuntary movement of the muscles of the hands and arms. If we assume that the operator is honest, we must admit the movements to be involuntary. In using the rod the hands are held in a strained, unnatural position, which renders it very difficult to hold the twig for any great length of time in the prescribed position without causing the muscles to twitch and thus compel the branch to dip.

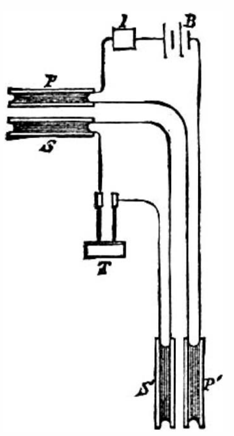


Fig. 6.—INDUCTION BALANCE.

The mineral rod illustrated in Fig. 2 is formed of a tube preferably, though not necessarily, of bamboo, with compartments at its ends. In one compartment is placed a piece of loadstone, and the other is partly filled with quicksilver. Both ends are corked and the instrument is held as shown in the cut. When the loadstone end dips it is supposed to indicate iron, but when the quicksilver dips it is taken as an indication of precious metals.

Although it does not seem advisable to multiply the accounts of these unscientific and worthless instruments, still, to convey an idea of the variety of devices of this class in existence, one more example is illustrated. The instrument consists of a small bottle suspended by a string and covered with thin cloth tied around the neck of the bottle. A specimen of the metal or mineral sought for is placed in the bottle. The string by which the bottle is suspended is held by the hands as steadily as possible. The bottle first revolves in one direction and then in the other. When it stops it begins to oscillate like a pendulum. The line of vibration is supposed to point to the object sought. The operator carries the device in the direction indicated until vibration ceases; the point where this occurs is the spot where the mineral or other substance looked for is to be found. If several different substances are looked for, a sample of each must be put in the bottle.

It is needless to say that all these devices and methods are devoid of any scientific principle, and if they ever give indications that lead to a find, it is either accident or coincidence. In the case of the last instrument described, the string naturally untwists when the downward pull of the weight comes upon it, and the acquired momentum of the revolving bottle causes it to continue to revolve after the string is untwisted, and twists the string in the opposite direction. The torsion thus produced revolves the bottle in the opposite direction, and so on until equilibrium is established. This will take some time; perhaps a half hour or more. At the expiration of this time the hands of the operator are so tired as to be incapable of holding the string steadily, and as a result the oscillations follow.

As to the scientific divining rods—if such a term can be applied to scientific instruments—the simplest of these is the miner's compass, shown in Fig. 4, and familiar to most readers of this article. It is simply a magnetic compass needle arranged to swing in a vertical plane. Its pivots being jeweled, it swings freely and points to any body of iron or magnetic ore contained in the earth. It is operative for a considerable distance, and has been used for years for locating iron mines; but it is of no use whatever for other than magnetic metals or ores.

In Fig. 5 is shown an instrument devised by the writer, in which a coreless induction coil of peculiar construction is used in connection with the telephone for indicating the presence of metals. The induction coil consists of a primary coil, preferably of rectangular form, made of coarse wire, No. 18, and connected with a rapid automatic circuit breaker and battery. The secondary coil is made of fine wire, No. 36, and is arranged exactly at right angles to the

Fig. 2.—ROD FOR IRON AND PRECIOUS METALS.

coarse wire coil. A telephone is connected with the secondary coil. If the primary circuit is continuously and rapidly interrupted while the coil is not in the vicinity of any metal or magnetic material, no sound will be heard in the telephone, as all the inductive influences are equal and opposite; but when the coil is held in proximity to a body of metal or magnetic ore, this equilibrium is disturbed and the sound is heard in the telephone.

The distance through which this instrument is operative depends upon the diameters of the coils and the strength of the current used in the primary coil. The larger the coil and the larger the current, the greater will be the penetration of the inductive effect. As the induction is effective for only a few inches in an ordinary coil of 6 or 8 inches in length, the instrument is useful for minerals lying near the surface. It may be used to advantage on the sea bottom, along cliffs, in wells and borings, and upon ground abounding in metals lying near the surface, by simply causing it to pass over or near such surfaces. When it is to be used under water, it must of course be inclosed in a waterproof casing of non-metallic material.

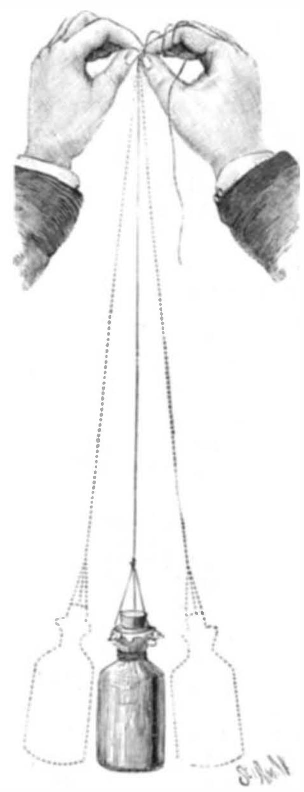


Fig. 3.—GOLD FINDER.

This instrument, which is an induction coil pure and simple, should not be confounded with the induction balance described below.

The induction balance invented by Professor D. E. Hughes has had a number of useful applications, one of which is the electric submarine detecter of Captain McEvoy. Professor Hughes demonstrated the extraordinary sensitiveness of the apparatus to the presence of small pieces of metal when brought near to one or other pair of coils.

The arrangement of the balance will be understood from Fig. 6, where P S and P^1 S^1 are the four coils of the balance, arranged in pairs separated from each other and connected by insulated wires. The coils, P and P^1, are joined together through a battery, B, and a key or interrupter, I, thus constituting the "primary" circuit of the balance. The coils, S S^1, are connected through a telephone, T, and constitute the "secondary" circuit of the balance. The interrupter, I, may be either manipulated by hand or automatically, so as to give a continuous action. Whenever the primary circuit is closed by its means, a current traverses the primary coils, P P^1, and induces a corresponding current in the secondary coils, S S^1. This current is of course audible in the telephone, T, but by reversing one of the secondary coils, say S^1, the current induced by the primary coil, P^1, in the coil, S^1, is made to oppose the current induced by the other primary coil, P, in the other secondary coil, S, so that it is possible to cause these two induced currents to annul one another and produce silence in the telephone.

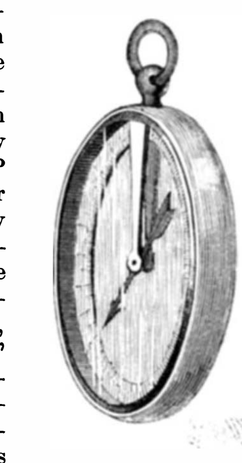


Fig. 4.—MINER'S COMPASS.

This is done by making the two primary coils and also the two secondary coils alike in all respects, and placing the secondary, S, at the same distance from P that S^1 is from P^1. The final adjustment to produce silence in the telephone can be made by altering the distance between a secondary coil and its primary, say the distance of S from P, or it can be made by means of a small piece of metal adjusted near one pair of coils, as was originally shown by Professor Hughes. To employ this arrangement for detecting metal masses it is only necessary to obtain a sufficiently good balance in this way, and explore the field where the metal is supposed to lie by moving about the pair of coils, S^1 P^1. Then, if

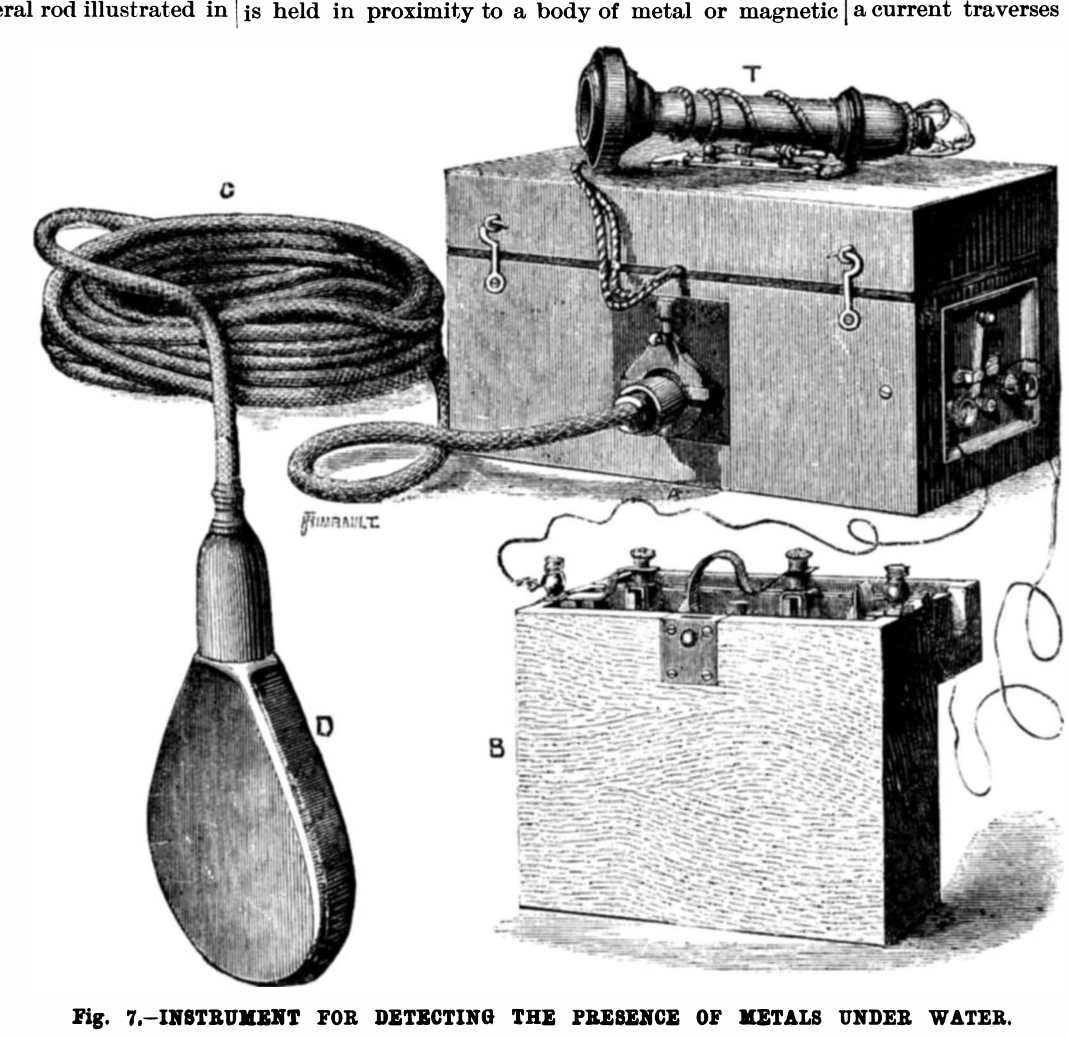


Fig. 7.—INSTRUMENT FOR DETECTING THE PRESENCE OF METALS UNDER WATER.

these coils come near a piece of metal, the inductive disturbance which its presence creates will upset the existing balance, and the telephone, before silent or nearly so, will give out distinctly audible sounds, owing to the predominance of the induced currents in the secondary, S^1, over those in the secondary, S.

The idea of applying the balance to the detection of metals has been worked out by Captain McEvoy, who has reduced it to a thoroughly practical form. This

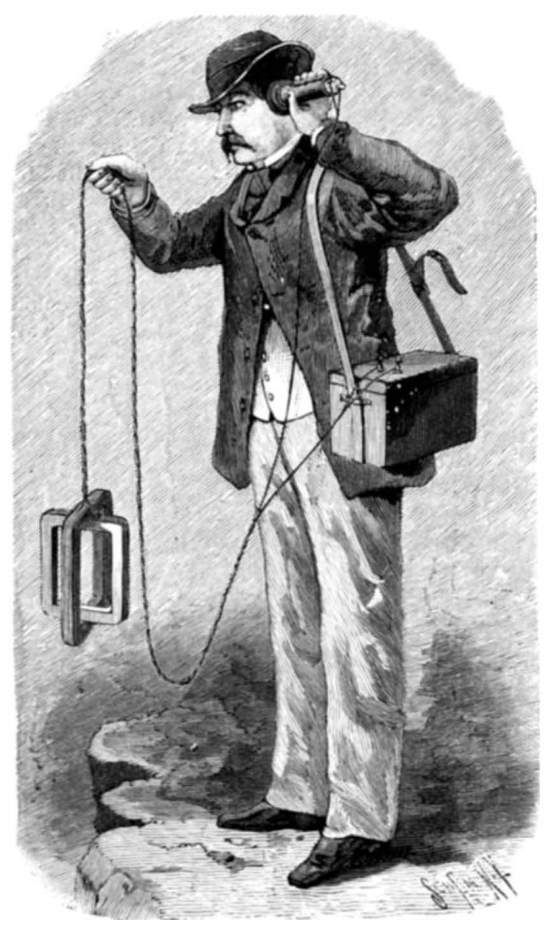


Fig. 5.—ELECTRICAL ORE FINDER.

actual apparatus is illustrated in Fig. 7, where A is a portable case containing the adjustable coils, P S, and the interrupter, I; B is a voltaic battery of two cells, which may be replaced by a small magneto-electric machine giving alternating currents; T is the telephone in the secondary circuit; C is an insulated cable conveying the wires connecting up the two pairs of coils; and D is the detecting or exploring case containing the two secondary coils, S^1 P^1. The coils, P S, inside the box, A, are separated by a layer of soft India rubber, and an ivory screw passes through both coils and the rubber washer between. An ebonite head to the screw is adjusted by hand so as to press the coils together or let them further apart by regulating the pressure between them and the India rubber. The simple device adjusts the balance of induction and reduces the telephone to silence.

The interrupter is a special device which consists of a small iron reed or tongue kept in vibration by a small double-poled electro-magnet, thereby interrupting the current a certain number of times per second, so as to give out a definite note which is easily recognizable in the telephone.

A switch, E, at the box turns the current from the battery on and off the interrupter at a moment's notice. The telephone is the ordinary speaking receiver of Bell.

The cable, C, is insulated with India rubber having its pores filled up with ozokerit or black earth wax forced in under pressure and when in a hot fluid state. It is further protected with an outer braided sheathing, and is fitted to the box, A, by an ingenious socket, which in an instant establishes connection between the corresponding primaries and secondaries, and locks them together. The detecting case, D, is made of wood soaked with paraffin wax. It is watertight, and contains two exploring coils, S P, Fig. 6. When it is lowered into the water by the cable, C, and moved about, or dragged over the bottom, the instant it comes against a piece of metal, such as a torpedo case, a chain, or a submarine cable, it disturbs the balance, and the note, heard in the telephone very faintly until now, becomes unmistakably loud and clear. It is, indeed, somewhat surprising to find so marked an effect.

If there is any objection to this instrument, it is that a body of metal lying in the plane of the coil will not affect it.

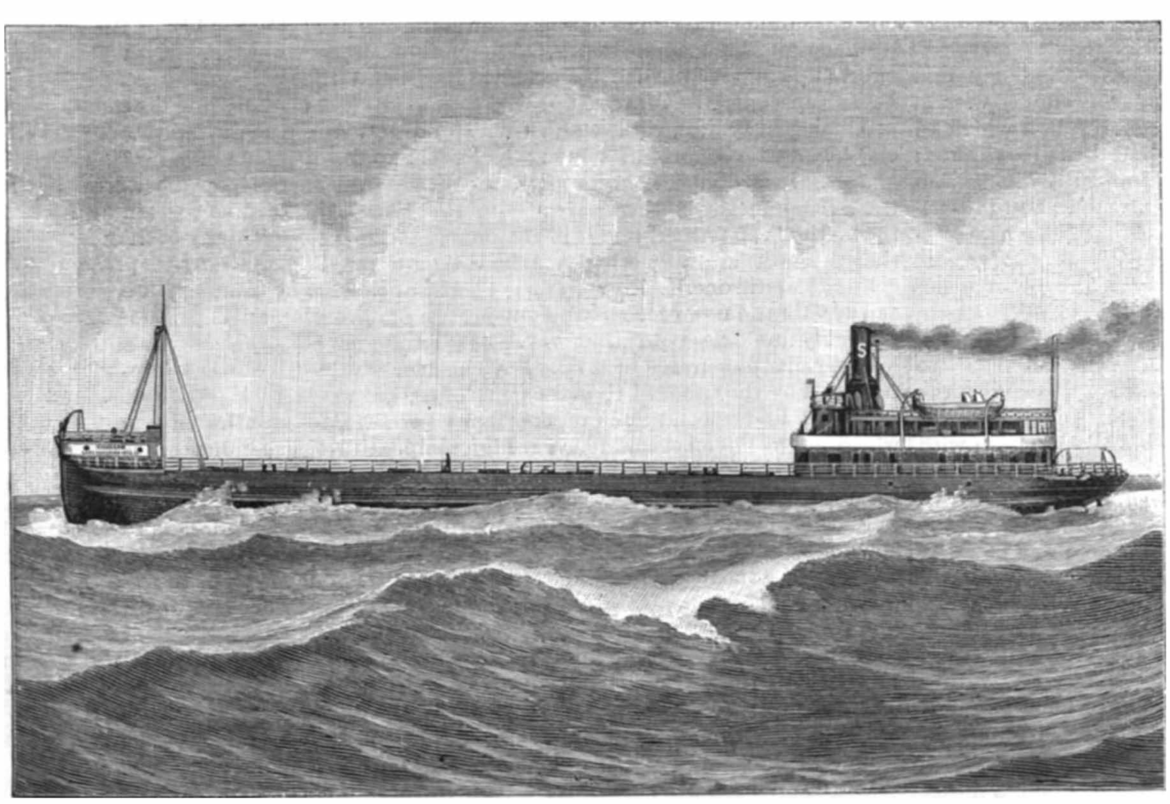
Pertinacious John Nash.

When a pupil in Sir Robert Taylor's office, John Nash had an early opportunity of bringing himself into notice. Sir Robert, on one occasion, putting before his clerks some plans to which certain alterations were needed in an unusually short space of time, was annoyed at being told that it was impossible to do what he required. This being overheard by young Nash, he ventured to ask if he might undertake the task which had been declined by his superiors. Sir Robert, struck by the earnest manner of the boy, granted his request. Nash immediately went to his room, procured paper and candles, and, sitting up all night, labored incessantly at the drawings, and by the time appointed appeared before Sir Robert with the plans completed. As another illustration of Nash's perseverance in after life, and his determination never to be overcome by seeming difficulties, it is told that on one occasion, having to go to some out-of-the-way place in Wales, he disdained the accustomed road, which was circuitous, and resolved to seek a more direct path to his object. Setting out on foot, he encountered many hedges, ditches, and fences, most of which he passed, but not without difficulty. At last meeting with a locked gate, awkwardly framed and inconvenient to mount, he was seen to retrace his steps several hundred yards, make a sudden run and attempt to vault over the gate. Failing in this, again and again he put forth his strength, and nearly accomplished his aim; at last stripping himself of his coat and waistcoat, by a longer run and a desperate spring he succeeded in clearing the barrier. He was then seen to climb deliberately over the gate, retrace his course, put on his clothes, and proceed quietly on his way.—*The Architect.*

THE STEEL STEAMER CHOCTAW.

The builders of vessels for the freight business on the great northern lakes are sharply competing with each other in the building of the most economical and efficient craft for the enormous transportation service now being done, and which is growing with marvelous rapidity. The ability of a vessel to carry an extra 100 or more tons of cargo, the efficiency of its engines in comparison with its coal consumption, its average rate of speed and freedom from liability to any sort of accident likely to interfere with the daily performance of its full work, are all carefully considered in the making of contracts for the new freight steamers now being built for the lake trade. This is necessary because there is so much competition in the carrying business that the smallest differences in the efficiency of the vessels often mark the line between a profitable or a losing business for the owner of a vessel, and on this account the builders are constantly making improvements in the steamers they are now turning out for this work.

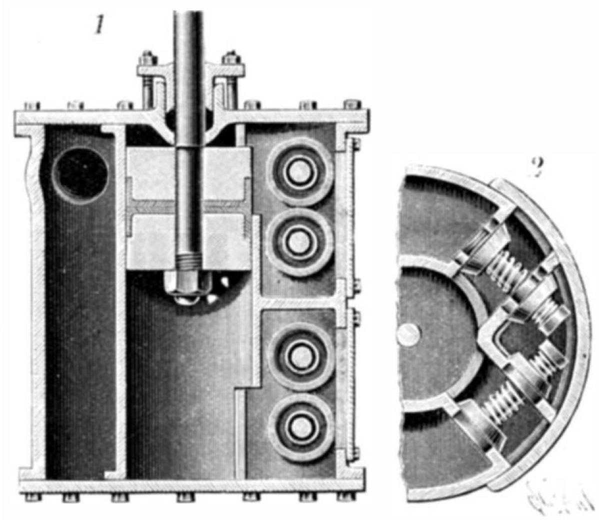
The accompanying illustration of the new steel steamer Choctaw, built by the Cleveland Shipbuilding Co. for the Lake Superior Iron Co., represents one of the latest models of this class of vessels. She is 266 feet long on the water line, 38 feet beam, and her moulded depth is 22 feet 4 inches. She will carry 2,683 net tons of fuel and cargo on a draught of 15 feet, her speed, light, being 13 miles an hour, and 12 miles an hour when loaded. Her engines are triple expansion, with cylinders 17, 29, and 47 inches, respectively, and a stroke, common, of 36 inches. She has two boilers, each 11 feet in diameter and 12 feet long.



THE STEEL STEAMER CHOCTAW.

AN IMPROVED FIRE ENGINE PUMP.

The illustration represents a double-acting fire engine pump in which the valves and interior mechanism are arranged to be more conveniently accessible than they have been with previous forms of construction, thus facilitating the repairing or replacing of the valves whenever necessary, and lessening the expense of keeping the engine in order. The improvement has been patented by Mr. T. S. La France, of 508 Spauld-



LA FRANCE'S FIRE ENGINE PUMP.

ing St., Elmira, N. Y. Fig. 1 is a vertical section, and Fig. 2 a horizontal section, showing a portion of the section and delivery valves, on the line of the side inlets for receiving water from either side of the engine. Both the pump barrel and casing are closed at top and bottom, neither end requiring to be opened, nor the back of the casing, the barrel, or its plunger needing to be removed, in order to get at the valves. All the valves, both inlet and outlet, are in the front portion of the casing, as shown in Fig. 2, and running vertically from top to bottom in this front portion are partitions, joined midway of their height by a horizontal dividing partition, forming upper and lower inlet valve chambers, while between these two sets of inlet chambers are upper and lower outlet valve chambers. The plunger is made with upper and lower solid heads, holding reverse cup-shaped leather or flexible packings between them. In the front of the pump casing are openings of sufficient size to take in or expose all of the valves, these openings being covered by removable separate lids, whereby access may be readily had to either or both the upper and lower sets of inlet and outlet valves. By this arrangement of the valves and valve chambers the pump barrel and its outer casing may be cast in a single piece if desired.

Costa Rica.

Although Costa Rica is only about half the size of New York State, its list of birds numbers 730 species. It is a country of forests and of all sorts of climates, from the torrid sea coast to that found at an elevation of 11,500 feet, the top of the volcano Irazu, where ice forms.

The trees are not deciduous, although their leaves fall in part during the dry season, which extends from October to May. At the end of the rainy season, many North American migrants appear, and as the dry season advances they retreat to the coast region, and are not seen again till another year. Bird life is more abundant during the wet season, for the reason that fruit and insects abound at that period. The breeding season nearly corresponds with that of the United States.

Near San Jose, at an elevation of 5,000 feet, are what are called "the prairies," about five miles square. They become flooded to the depth of about an inch from September to February, and on them are found a number of species of water fowl and waders.—*George K. Cherrie.*

THE HOMESTEAD DIFFICULTIES.

The Carnegie Steel Works, at Homestead, Pa., several views of which are given on our first page, are among the largest of the kind in the world. Their output of steel recently has even been compared to that of the famous Krupp establishment at Essen. The immense plant, in its machinery and buildings, is all of the most modern type, embracing the most recent improvements, Superintendent Potter testifying before the Congressional Investigating Committee that, by reason of the improved machinery, "the output was 50 per cent greater than that of any other mill in the world!" This seems to be a truly enormous gain, but the improvements which have been but recently made in the machinery and methods in the manufacture of steel in large quantities are hardly appreciated by those not directly engaged in the business. The new beam mill, completed within the past two months, cost nearly a million dollars, and the entire establishment has been absolutely created within the past ten years, for it was only half a score of years ago that Homestead had less than a thousand inhabitants. Then it was an unimportant and unknown suburb of Pittsburg, while now it has over 12,000 inhabitants, substantially all of whom have obtained their livelihood and made for themselves comfortable homes by the building up of the great steel works at that point.

But at this thriving and prosperous industrial center there has been a "labor difficulty" which has attracted the attention of the whole country for the past six weeks, and, on July 6, the matter was the occasion of a bloody engagement, as of between opposing forces engaged in actual war, in which some twenty men were killed and a far larger number injured.

On July 1 the 3,800 workmen employed at the mills were paid off in full, and work was "shut down," the company having declined to sign an agreement to pay a scale of wages for the future which had been demanded for the men by the Amalgamated Association of Iron and Steel Workers, a labor organization to which all the men belonged. The men and the company had got along under a similar agreement for the three preceding years, although there had all the time been a good deal of friction, from the fact that the company found it difficult to deal with its men individually as to many details of the work, and on this account, after a failure to come to an agreement as to a future scale of wages, the company decided to no longer recognize or deal with the association as a body, but to hire all the help needed without regard to any labor organization. It may be briefly stated that the company had asked: First, a reduction in the minimum of the wage scale from $25 to $23 for 4×4 Bessemer billets; second, a change in the date of the expiration of the scale from June 30 to December 31; and third, a reduction in tonnage rates at those furnaces and mills where important improvements have been made, and new machinery has been added that has greatly increased their output, and consequently the earnings of the workmen. Where no such improvements or additions have been made, no reduction in tonnage rates was asked. It has been conceded by the men that the proposed reduction of wages would affect only 325 men out of the total number of employes.

From the date of the stopping of work at the steel works the plant of the company was placed practically in a state of siege by the former workmen. On the 5th of July, a sheriff's posse, in response to the Carnegie Company's demand for protection, attempted to take nominal possession and post guards at the works; but they were captured by the men and sent out of town. The company had, however, in anticipation of trouble with their workmen, been making preparation to meet it for some time previous. They had erected a high fence around their grounds, with a barbed wire strung along its top, through which an electric current might be sent; placed a great search light in commanding position, put up a big instantaneous camera at an advantageous point, and in various other ways were preparing to protect their property. As a part of this system of defense, a force of Pinkerton detectives had been engaged as watchmen, and they were to have been installed at the works in the early morning of July 6. Some 300 of the men, hired for this purpose, were, therefore, taken on two barges, in tow of tug boats, from Pittsburg to the works, which are on the south side of the Monongahela River, about eight miles southeast of its junction with the Allegheny. The fact that the company was thus moving to place Pinkerton men in its works at Homestead created the greatest excitement in the latter place.

The news was telegraphed ahead and, on the arrival of the barges, just before sunrise, the river banks at Homestead were crowded with angry and threatening workmen. It had been intended to land the men from the barges near the pump house, fully a mile within the boundary line of the premises of the company, but the crowd speedily broke down the fence and poured over the company's grounds along the steep embankment skirting the river, reaching the landing place ahead of the boats.

Then succeeded an engagement which lasted nearly all day. It has been disputed from which side the first shot was fired, but the firing quickly became general on both sides, and was kept up with occasional intermissions until three o'clock in the afternoon. The strikers secured a small brass ten-pounder cannon and kept up a fire from it on the barges from within a steel billet embrasure on the grounds, while another cannon opened fire also from the opposite side of the river. The barges were of strong build, having been made for shipping iron, and as an extra precaution they had been lined with heavy steel plates. Little impression was therefore made upon the barges by the fire of the men on the banks, and then it was sought to fire the boats, as shown in one of our views, which is reproduced from a photograph. Oil was spouted on the decks and sides of the boats by means of hose and a small fire engine of the company, but the oil was a lubricating mixture and did not burn well, and the failure of this attempt was followed by an effort to burn the boats with the flame from a natural gas pipe. The tug boats had cast loose and left the barges early in the day, and at 5 o'clock the men on the barges, seeing that there was no hope of escape, surrendered to the mob. Before surrendering they were promised protection, but on the way from the boats to the Opera House, where they were finally lodged as prisoners for the night, they were most brutally assaulted and maltreated by the mob which lined the streets of Homestead.

Within a week after this bloody exhibition of organized mob violence Homestead was taken possession of by the State militia of Pennsylvania, and a force of five or six thousand soldiers was encamped in the town and upon the hills around, their tents upon the hillsides being visible in one of the views, and from this date, under military protection, the company has been gradually filling its workshops with non-union workmen. Another view shows the headquarters of the Amalgamated Association at Homestead, where the men have been accustomed to assemble to mature their plans, and from which the leaders directed their campaign against the Carnegie Company. The office of the latter company in Pittsburg, shown in one of the views, has a peculiar interest, from the fact that here was shot, a few days later, Mr. H. C. Frick, the managing head of all the different Carnegie establishments. A New York anarchist, a Polish Jew named Berkman, went to Pittsburg for the special purpose of killing Mr. Frick, and succeeded so far as to shoot him twice in the neck and inflict several stabs in his back. The wounds did not prove fatal, however, and Mr. Frick has since sufficiently recovered to again assume full charge of his vast business interests. It is not claimed that the would-be murderer had any direct connection with the strikers' organization, but there is only a question of degree of crime between the mob which invaded the grounds of the Carnegie Company, and for hours took part in the bloody work there on July 6, and the dastardly miscreant who, on July 23, sought to aid in carrying out the work of the rioters by killing Mr. Frick.

For the photographs from which some of our views are made we are indebted to Mr. B. L. H. Dabbs, of Pittsburg.

Artificial Precious Stones.

What promises to be a most important discovery has been made by one of our Glasgow scientists. Although imitation gems are obtainable in any required quantity, the production of crystals having the hardness, durability, and other qualities, both physical and chemical, of natural stones has been one of the unsolved problems of applied chemistry. The most advanced efforts up till now have been made in Paris, and the French specialists have at least proved the possibility of producing sapphires, rubies, and other stones by artificial means, their products being real gems, and not glasses. It is doubtful, however, if the originators of the French methods themselves claim that theirs are the methods of nature, and it is reasonable to suppose that the most natural method will be the most practically successful one. Although no geologist or chemist can declare the new process to be the process of nature, yet many analogies point that way.

Experimenters in this field may have been partly discouraged by the thought that the gems of nature were produced under conditions of enormous pressure, to which might have been added very high temperatures, and that they were in some cases the products of long periods of time. It is possible, however, that too much weight has been given to this point. In the process now under notice no such discouraging conditions are present, and the method is wonderfully simple. Even working on the laboratory scale, using small vessels, stones have been obtained over one-sixteenth of an inch in diameter, and very large numbers have been formed approaching that size. There is no reason to doubt that working on a larger scale will yield stones of any size likely to be required. The noble nature of the products is beyond doubt, as they are very hard, infusible at all ordinarily attainable temperatures, and insoluble in any acid. The bulk of the gems are white or rather colorless sapphires. They are compact and transparent crystals, and many specimens have a splendid luster. By subsequent treatment some of them have taken on the sapphire blue.

Some of the specimens seem to contain a small amount of carbon. This element is sometimes present in small quantity in natural emeralds, a fact not generally stated in books on the subject. In a few specimens the proportion of carbon seems to be considerable, and there are present individual crystals having physical properties more nearly allied to the diamond than to the sapphire. In nature diamonds are often found associated with other gems. In any case the products contain little or no silica, this compound being the characteristic ingredient in all kinds of glass. Apart from the possibilities of the process in the direction of producing the diamond, the chief point already established is that of having found an easy method of crystallizing alumina. The Oriental ruby, Oriental amethyst, and other gems coming under the heading "Oriental," are all of them only variously colored sapphires, and alumina forms the chief constituent of the series.

There is little doubt that the process will yield the ruby and other varieties. Apart from ornamentation, their hardness will fit them for mechanical purposes, and their cutting power is remarkable, perhaps due to the small amount of carbon already spoken of. The author of the process has sought the opinion of several of the foremost men of science, and their general verdict has been very favorable. The discovery may prove to be one of the most important yet made in mineralogical chemistry, and the future developments both commercially and scientifically difficult to estimate. The originator of the process is Mr. James Morris.—*Glasgow Herald.*

THE MOON AND MARS.

A most interesting spectacle in the southern sky, in connection with the recent near approach of the planet Mars, was presented on the evening of August 7, when the planet was for some hours apparently very near the full moon, as shown in the accompanying view. When one remembers that the planet was some 35,000,000 miles away from us, while the moon's distance is only about 240,000 miles, that the diameter of the planet is just about twice that of the moon, and that the planet itself has two small moons coursing around it at a rapid rate, it was not necessary to call up the further comparisons, almost everywhere entertained, as to the probability of life on Mars and the absence of life on the moon, to render the sight one well worthy of attracting and holding the attention, aside from its beauty as a mere spectacle.

THE LOOPED PATH OF MARS.

My father, Professor Richard A. Proctor, was very much interested during his lifetime in the study of the miniature earth, Mars; and about which now the scientific world is especially interested. In his magazine *Knowledge* for March 31, 1882, vol. 1, he makes reference to a map, published in an earlier number (March 24), of the looped path of Mars, designed by himself. With regard to it, he wrote as follows: "There are some 600 positions of the planet (all separately laid down before the path was carried through them), and the constructions for these involved many hours of labor." The following is the illustration of the looped path, with the accompanying descriptive text, as written by my father:

"Many even of those who have read the usual descriptions of planetary motions, in our text books of astronomy, are perplexed by the way in which the planets pursue

> Their wandering course, now high, now low, then hid,
> Progressive, retrograde, and standing still.

"Mars, Jupiter, and Saturn during the last few months have given striking illustrations in the skies (as indicated in our maps) of their strange and at first view fantastic and irregular motions. Mars, in particular, traverses a singularly devious course upon the background of the starlit heavens. It has seemed to me that it would be interesting to exhibit the real course of this planet, the one of all the sun's family whose path, with reference to the earth, has the most complicated form. Of course, in reality this planet travels around the sun in an ellipse which is almost circular in form, though considerably eccentric in position. The earth also pursues an elliptic path, smaller in size, still more nearly circular in form, and much less eccentric. But viewed from the earth, the planet Mars, in consequence of the combination of these two circling (but not strictly circular) motions,

travels on such a looped path as is shown in the accompanying map. Here the planet's position, as viewed from the earth (his geocentric position, as it is called), at the successive oppositions (or times of nearest approach to the earth), is shown by the small dot at the end of the dated radial line. Then, at successive intervals of ten days, measured forward and backward from the time of opposition, Mars has the positions indicated by the successive dots. Of course, there is a place in the outermost part of each whorl where these ten-day dots meet without an exact ten-day interval; this, however, is unimportant, as in these parts of his geocentric path Mars is invisible. At the proper places along the planet's looped geocentric path are shown the places where Mars is in perihelion (M), aphelion, M', at a rising node (or crossing the plane of the earth's orbit from north to south), attaining its greatest height (indicated by the length of the "I") above that plane at the point marked $\hat{I}$; gradually returning toward the plane of the paper, which it crosses again at a point marked ☋; then attaining its greatest distance below the plane of the paper at the next point marked $\underset{\vee}{I}$; whence it returns gradually to the plane of the paper at a point marked ☊; and so on continually." MARY PROCTOR.

616 North Sixth Street, St. Joseph, Mo.
August 7, 1892.

Prof. Pickering's Observations of Mars.

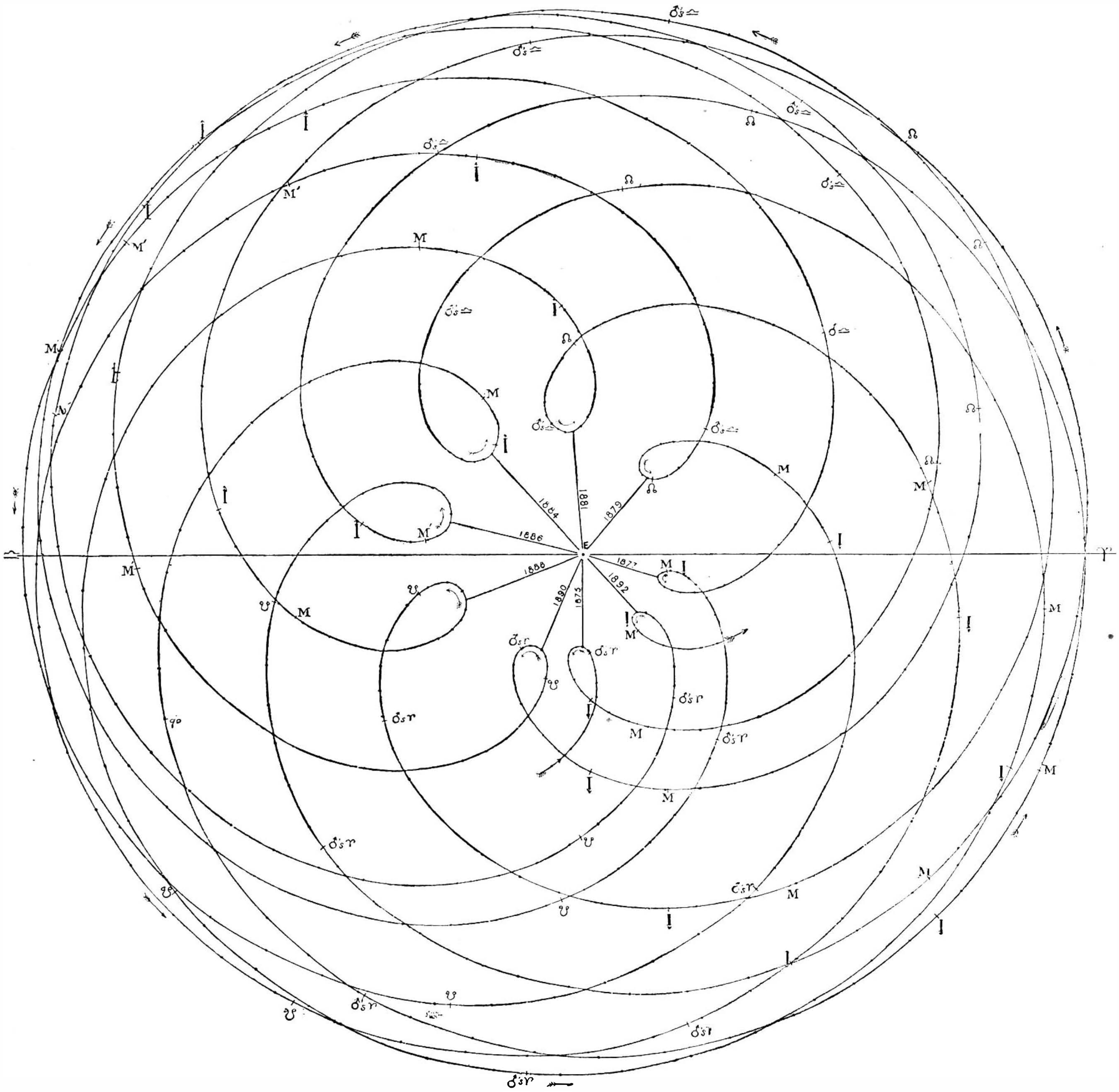
In December, 1890, the Astronomical Observatory of Harvard College sent out an expedition to Peru in prosecution of its self-assumed task of making a complete map of the heavens. In order to do this it had been found necessary to establish branch observatories in various parts of the United States and other countries, so that the entire sky might be mapped out. A preliminary station had been established at Chosica, Peru, in May, 1889, but it was found necessary to remove the observatory to a point where the cloudy season was at a minimum. Messrs. S. I. Bailey and M. H. Bailey, two of Professor Pickering's assistants, were in charge at the Chosica observatory. Mr. M. H. Bailey superintended the removal and made a temporary erection in the desert of Atacama, one of the driest spots on the earth and nearer the coast than Chosica. It was subsequently determined to establish a permanent observatory at a point near the city of Arequipa, where a position was secured at an altitude of about 8,000 feet.

To this point Professor W. H. Pickering, accompanied by his family, started. The party does not expect to return to North America for four or five years. By the end of that time Professor Pickering hoped to have mapped out the entire southern half of the heavens, which, as is well known, is far richer in bright stars, clusters and nebulæ than the northern half, with which we are familiar. Professor Pickering also expected to be able to secure photographs of the moon which will be superior to any yet made. For instance, he hoped to be able to produce in that clear atmosphere a photograph six feet in diameter of the lunar surface.

Another of the special objects of the expedition was to observe the planet Mars during its present opposition. The chief difficulty with observing Mars in this country and Europe at the present time is that the planet is now in almost the lowest portion of the ecliptic, near to the horizon, and consequently the telescopic view is affected by all sorts of atmospheric disturbances.

In Peru, however, the planet will be almost directly overhead, and the observatory being situated at a high altitude, the difficulties of view occasioned by dense atmosphere will be avoided. With his superior instruments Professor Pickering will, no doubt, be able to make remarkable discoveries. The access to the observatory is very easy, as a line of railway leads directly from the coast to this point, and delicate and heavy instruments may be transported with ease and safety.

Among the instruments which were taken to Peru were the Harvard Observatory eight-inch photographic doublet, a five-inch visual telescope and an instrument for measuring the brightness of stars. Professor Pickering took with him his own effective astronomical "battery," consisting of a thirteen-inch photographic telescope with an eight-inch finder, a twenty-



THE GEOCENTRIC PATH OF MARS—BY THE LATE R. A. PROCTOR.

(☊) at a descending node (or crossing the plane of the earth's path from south to north), (☋) the place where he attains his greatest distance north($\hat{I}$) and south ($\underset{\vee}{I}$) of the plane of his orbit; the place where Mars is at the point of his orbit corresponding to the vernal equinox (beginning of spring) of his northern hemisphere, marked ♂'s ♈, and the corresponding point for the autumn of Mars, marked ♂'s ♎.

"The scale of the drawing is the same as that of my picture of the orbits of the terrestial family of planets (Mars, Earth, Venus, and Mercury) in the 'Encyclopædia Britannica,' viz., fifty million miles to the inch, and on this scale the lines I, I, etc., indicate the greatest distance attained by Mars north and south of the plane of the ecliptic. The northerly displacement, it will be seen, is the greater.

"The path of Mars must be regarded as passing above the plane of the paper, at a point marked ☊, gradually

inch reflector, made for the purpose of finding faint nebulæ, and an instrument with which he discovered the great spiral nebula in Orion, also a portable transit instrument for determining time and a seismometer for observing earthquakes.

Last year a visual twelve-inch telescope was added to the equipment, so that there can be no failure of the expedition on the ground of lack of instruments. Owing to the lack of building materials in the country where the observatory is erected, the university was obliged to send with the astronomical outfit wood and iron for constructing the buildings and domes and iron piers for the telescopes.

The New York *Herald*, to which we are indebted for the foregoing particulars, has received a special telegram from Prof. Pickering, dated at Arequipa, August 9, in which the professor says:

In my observation of Mars I have seen two large areas near the equator which are permanently blue. Near the edges they appear light blue. The light is slightly polarized.

The total size of the area is about 500,000 square miles, one-half the size of the Mediterranean Sea.

On June 23 a small dark spot appeared in the southern snow cap. Later this spot lengthened rapidly, and early in July it was a thousand miles long, dividing the snow in half.

Sixteen hundred thousand square miles of snow have melted within the last thirty days. The melted snow has apparently been transferred to the seas, across land.

Small, dark areas, surrounded by snow, appeared on July 10, and two days later I first saw a dark line in the fork of a Y shaped mark in the direction of the seas. The line became more conspicuous on July 14, and on the 16th a dark area about the size of Lake Erie appeared on the northern side of the stem of the Y, which was connected with the northern sea. The next day there appeared a large dark gray area near the northern sea.

This had grown much fainter by July 23, and a new area appeared to the south of the northern sea, concealing its outline. The line in the fork of the Y had disappeared, but the area of the Y had extended. On July 24 a large dark area, apparently either a lake or a sea, appeared near the melting snow, and on July 25 the southern branch of the Y became very narrow. The outlines of the northern sea were seen again, a narrow white line stretching north from the snow.

Many other changes were noted. Rapidly changing, faint whitish areas were seen. Green areas near the poles have not been seen for many weeks, but traces were recently suspected, and a bright green area was distinctly seen near the north pole last night.

Magnetic Photography.

Prof. E. J. Houston describes his new mode of photographing the magnetic groupings of iron filings as follows: I place a dry sensitized photographic plate over the magnet whose field I desire to fix, and after the characteristic groupings of filings have been obtained, I expose such plate while over the magnet to the light of a gas flame for a few seconds.

This operation is necessarily performed in the dark photographic room. After exposure the light is turned out and only the non-actinic red or yellow light left.

The filings are allowed to fall off the surface of the dry plate, and the finer particles that still adhere to it are brushed off by a feather or dry camel's hair brush. The plate is then developed and fixed in the usual manner.

This process of obtaining records of magnetic fields produces true negatives, which, when employed for printing by blue print, silver print, platinotype, or similar process, produce excellent positives.

As the negatives so obtained are more permanent than the positives obtained by the use of the filings themselves, they permit the taking of an indefinite number of photographic prints.

A DEEP BASEMENT.

To make a basement on Broadway, New York City, as deep as the one shown in our illustration, is a work involving some interesting, though by no means novel, engineering features. To accommodate the great rope traction wheels which are to be used in the cable railway service of the Broadway railroad, it was necessary that this basement, in which the plant is to be located, should be nearly 40 feet deep, and this is the depth at which, on the corner of Houston Street and Broadway, a permanent water-holding stratum is reached. It was especially desirable to have the plant all placed beneath the street level, so that the space above might be profitably utilized for stores and other purposes, Broadway property at this point being very valuable.

In order to have the room in this basement as clear as possible from obstructions, and of the whole size of the building, 200 by 225 feet, the method has been followed of sinking in the water-holding stratum separate foundations for the numerous pillars which are required to support the interior of the superstructure. A great room is thus provided, in which there will be no interior walls, in which will be placed the four engines, of 1,000 horse power each, for driving the cables. The engines are to be arranged in pairs, each pair operating a shaft on which is a rope traction wheel, from which the power is transmitted, through other traction wheels, to the large wheels on the shafts carrying the cable drums. There will be four of these large traction wheels on cable drum shafts, the wheels being each 32 feet in diameter and 8 feet 4 inches wide over the face, weighing over 100 tons each.

DEEP BASEMENT OF THE BROADWAY R.R. POWER HOUSE, CORNER OF HOUSTON STREET.

The Rights of Labor and the Laws of the Land.

The laws of this country are the fairest, the most reasonable and the most just laws that history records. The principles which they embody are those which have been recognized as fair and just by all civilized nations in all ages, by the best and ablest men in those nations, and also by the great religious leaders and organizations of the world. The liberty of the individual and the welfare of the state are the two chief interests of all just laws and all good government. These two interests are cared for in this country more carefully and intelligently than they have been or are in any other. This is proved by the fact that to get an anarchist we have to import him ready made. The sunshine of our laws and customs is too genial for their breeding here. It is also proved by the fact that hundreds of thousands, yes, millions of men, since we became a nation, have under our laws developed their lives from a low beginning in ignorance, poverty and obscurity into intelligence, usefulness and prosperity. It is not under bad laws that such things can be done.

It is only reasonable, therefore, that labor organizations should be urged not only to obey the laws of the land, but to teach their adherents that to obey these laws is their first and most important duty. The weakness of these organizations has been, and is to-day, that they claim—not in words, perhaps, but in acts—that the organization of wage workers into unions gives them certain "rights" not before possessed. The leaders of labor unions can engage in no better work than to teach their followers that whatever claim of "rights" cannot be enforced under the law is not right, and must be abandoned. If this had been done by labor union leaders, the twelve men who were recently shot to death at Homestead would be alive to-day, and the red smear of murder would not appear on so many pages of the history of labor unions.

One of the facts which organized labor would do well to understand is that under the laws of this country a man may work for whom he pleases and for any price that may be agreed on between him and his employer, and that the employer may at any time cease to employ him and hire some one else in his place. Employes and employers have precisely equal rights in these matters. Another fact equally important is that the law will punish the man who, by physical force, prevents another from working. To do so is a lawless act, and that it is done by or for the benefit of organized labor makes no difference. The law does not take cognizance of organized labor any more than it does of red-haired or temperance, or Catholic or Protestant labor. And not only the law of the land, but also the sentiment of right-thinking people everywhere makes it an evil and an inexcusable act to prevent the man who needs work and wants to work from doing so. How much sympathy for labor is there in the sentiment which beats a man black and blue when he applies for the work the wages of which his hungry family needs—because he does not belong to a union? What sort of charity would that be which would refuse help to a starving child unless it was enrolled in some Sunday school mission class?

Still another point to be learned by combinations of labor is that they cannot claim from the law the same recognition which it gives to employers until they become equally responsible before the law. As it is now the employer can be compelled to make good any violations of contract with his employes. But if his employes, acting through a labor union, sign a contract to-day and break it, greatly to his pecuniary injury, to-morrow, he has no redress. This has recently happened at Pittsburg, where several hundred employes, after signing an agreement to work, broke their agreement without any lawful reason, leaving the works idle. In such a case the employer has no remedy. The labor union insists on being "recognized," and uses all lawful and even many unlawful means to secure recognition, and yet has nothing of that responsibility before the law upon which, only, can one business concern recognize another. When the law compels labor unions to become pecuniarily responsible for their actions, some phases of the labor question will be settled. Employers will prefer to deal with a responsible organization rather than with individuals.—*Railway Master Mechanic.*

The following directions for joining band saws are given by the Defiance Machine Works: Bevel each end of the saw the length of two teeth. Make a good joint. Fasten the saw in brazing clamps with the back against the shoulder, and wet the joints with solder water, or with a creamy mixture made by rubbing a lump of borax in a teaspoonful of water on a slate. Put in the joint a piece of silver solder the full size thereof, and clamp with tongs heated to a light red (not white) heat. As soon as the solder fuses blacken the tongs with water, and take them off. Remove the saw, hammer it if necessary, file down to an even thickness, finishing by draw-filing lengthwise.

would be in a condition of static equilibrium. I think the magnetic poles of the armature must move forward, turning the armature with them, while the brushes remain on the same segments of the commutators, and when they come on the next segment, so that the current passes through the next coil, the poles are recreated so to speak, one coil further back as regards direction of rotation, and again advance through the same angle, turning the armature, as before. Thus you have the motion necessary to produce energy. Is my idea correct? A. We think your idea is correct. 2. How much lead is it desirable to give the poles of the armature of a motor? A. Only enough to reduce the sparking to a minimum. 3. What would be the effect of too much lead? A. Increased sparking. 4. What would be the effect of no lead at all? A. It depends on the construction of the machine. If the machine requires lead to make it work to the best advantage, changing the brushes so as to give no lead would cause the machine to spark.

(4499) H. Z. writes: N. E. T. in Notes and Queries says his cigar lighter don't work properly. I have one like it. The probability is that his solution is polarized. If he washes the zinc and other elements and makes a new solution, he will find it works well. Two ounces each of bichromate of potash and sulphuric acid. Add water enough only to come within one-eighth inch of the zinc.

NEW BOOKS AND PUBLICATIONS.

A DICTIONARY OF ELECTRICAL WORDS, TERMS AND PHRASES. By Edwin J. Houston, A.M. Second edition, rewritten and greatly enlarged. 1892. New York: The W. J. Johnston Co., Limited. Pp. 562. 7×9½ inches. Price $5.

In this new edition of Professor Houston's dictionary there are over five thousand distinct titles with definitions and a superabundance of cross references. The definitions are concise and in the main accurate, and the illustrations are sufficient for the purposes for which they are designed. Taken altogether, the book is desirable and should be owned by every person who tries to keep up with these times, in which electricity plays so large a part. To the electrical engineer, electrician, and student of electricity, it is indispensable. Occupying as it does the pioneer position in the field, and being thus far the only work of its class, we bespeak for it the welcome it deserves.

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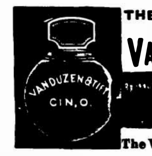

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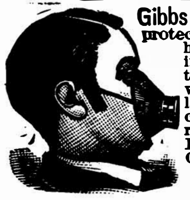

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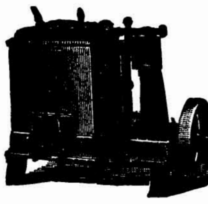

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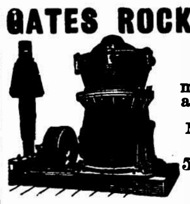

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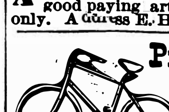

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U. S. ENGINEER OFFICE, ARMY BUILDING, NEW YORK, August 4, 1892.—Sealed proposals for the construction or sale of a Hydraulic Dredging Steamer for New York Harbor will be received at this office until 12 m. September 13, 1892, and then publicly opened. Specifications, blank forms, and all available information will be furnished on application to this office. G. L. GILLESPIE, Lieut.-Col. of Engineers.

U. S. ENGINEER OFFICE, BOSTON, MASS., August 6, 1892.—Sealed proposals for removal of ledge from the Merrimac River, Mass., will be received at this office until noon, September 6, 1892, and then publicly opened. Specifications, blank forms, and all available information will be furnished on application to this office. S. M. MANSFIELD, Lieut.-Col. of Engineers.

U. S. ENGINEER OFFICE, BOSTON, MASS., August 5, 1892.—Sealed proposals for the delivery of rubblestone in the breakwater at Sandy Bay, Cape Ann, Mass., will be received at this office until noon, September 9, 1892, and then publicly opened. Specifications, blank forms, and all available information will be furnished on application to this office. S. M. MANSFIELD, Lieut.-Col. of Engineers.

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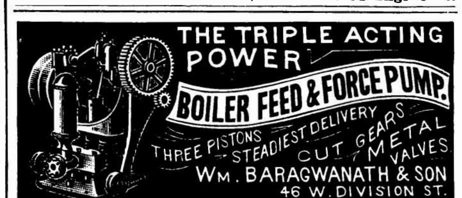

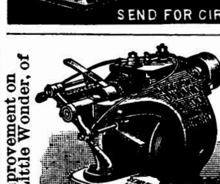

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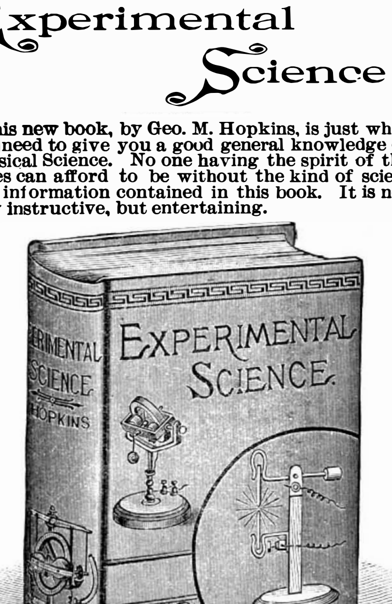

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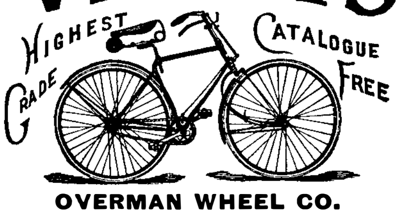

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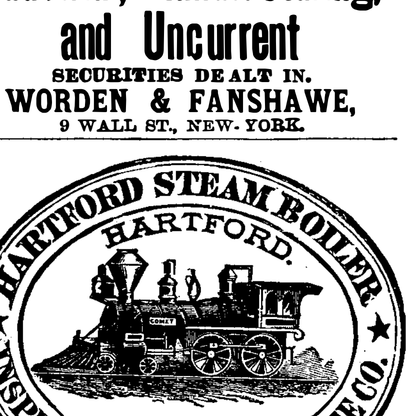

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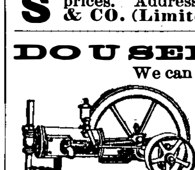

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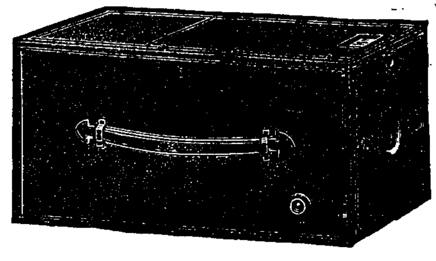

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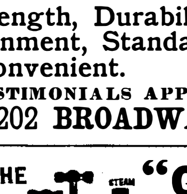

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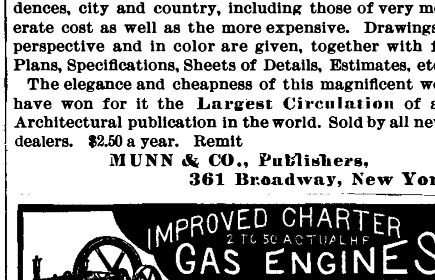

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